

$$\text{CNF: } A \rightarrow BC \quad A, B, C \in V$$

$$A \rightarrow x \quad x \in T$$

conversion ($CFG \rightarrow CNF$):
rules

pre-processing:
1. Remove empty string (if exists)
2. Remove lambda productions
3. Remove unit productions

aside:
int array [25];
array C[25] = {
 ...

CNF rules:

$$\text{I. } A \rightarrow x_1 x_2 \dots x_n$$

if $n=1$ then $x \in T$ since no unit productions
leave alone

if $n \geq 2$ introduce new variable(s) $B x_i$ for $\forall x_i \in T$
and then add P_{x_i} for $B x_i \rightarrow x_i$

II

if productions of form $A \rightarrow a$ or $A \rightarrow \emptyset$, keep.

if $n > 2$, then add new variable D_i

$$\rightarrow D_i \rightarrow BC \text{ where } B, C \in V$$

0⁺ add back in empty string if removed.

Ex Rule 1:

$$\begin{aligned} A &\rightarrow a & \checkmark \\ A &\rightarrow B \\ A &\rightarrow BC & \checkmark \\ A &\rightarrow a b & \equiv & A \rightarrow x_a x_b \\ & & & x_a \rightarrow a \\ & & & x_b \rightarrow b \\ A &\rightarrow a a & \equiv & A \rightarrow x_a x_a \\ & & & x_a \rightarrow a \\ A &\rightarrow a BC a & \equiv & A \rightarrow x_a BC x_a \\ & & & x_a \rightarrow a \end{aligned}$$

Ex Rule 2:

$$\begin{aligned} A &\rightarrow x_a BC x_a & \equiv & A \rightarrow x_{ab} x_{ca} & \checkmark \\ & & & x_{ab} \rightarrow x_a B & \checkmark \\ & & & x_{ca} \rightarrow C x_a & \checkmark \end{aligned}$$

$$\begin{aligned} A &\rightarrow BCD & \equiv & A \rightarrow x_{bc} D & \equiv A \rightarrow B x_{cd} \\ & & & x_{bc} \rightarrow BC & \\ & & & x_{cd} \rightarrow CD & \end{aligned}$$

removing empty string

$$S \rightarrow a A \quad \cancel{x}$$

$$A \rightarrow a \mid B$$

$$B \rightarrow bba$$

≠

$$S_0 \rightarrow a A$$

$$A \rightarrow a \mid B$$

$$B \rightarrow bba$$

1. remove lambda productions = none

$$S_0 \rightarrow a A$$

$$A \rightarrow a \mid B$$

$$B \rightarrow bba$$

≡ 2. remove unit production

$$S_0 \rightarrow a A$$

$$A \rightarrow a \mid bba$$

≡ I

$$S_0 \rightarrow x_a A$$

$$A \rightarrow a \mid x_b x_b x_a$$

$$x_a \rightarrow a$$

$$x_b \rightarrow b$$

≡ II

$$S_0 \rightarrow x_a A$$

$$A \rightarrow a \mid x_{bb} x_a$$

$$x_a \rightarrow a$$

$$x_{bb} \rightarrow b$$

$$x_{bb} \rightarrow x_b x_b$$

$$S_0 \rightarrow x_a A$$

$$A \rightarrow x_a \mid bb$$

$$x_a \rightarrow a$$

$$bb \rightarrow x_{bb}$$

$$bb \rightarrow b b$$

$$x_{bb} \rightarrow x_b x_b$$

$$x_b x_b \rightarrow b b$$

$$b b \rightarrow b$$

$$b b \rightarrow b b$$

$$b b \rightarrow b$$

$$A \rightarrow a \mid b$$

$$A \rightarrow a$$

$$A \rightarrow b$$

$$A \rightarrow c$$

$$\{int x\}$$

$$\{int y\}$$

$$\{int z\}$$

$$\{int s\}$$

$$\{int x, y, z\}$$